6.—The Field Occurrence of the Mt. Padbury Meteorite

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Fragmentation of the Mt. Padbury meteorite, a newly discovered mesosiderite, probably occurred at the penultimate stage of atmospheric flight, distributing fragments over a very small impact ellipse, the larger fragments being embedded several inches in the soil. The concentration of nearly 99% of the material in a circle whose area is only 0.4 that of the whole ellipse is notable and suggests that the line of flight was nearly vertical with only some minor fragments scattered further out when fragmentation occurred. Further fragmentation probably occurred on impact, and subsequently the material suffered considerable weathering and redistribution of the resulting fragments by secondary processes. This may indicate that the fall occurred many years ago—possibly centuries, but the unstable mineral lawrencite in the meteorite could have produced the same effect in a very short time.

Location

The find was made on Mt. Padbury station, the homestead of which is situated 68 miles north-north-west of Meekatharra. The site of find was 9 miles from the homestead on a bearing slightly south of east, at a point on 118° 15′ east longitude and 25° 42′ south latitude. The mountain from which the station takes its name is closely visible to the north-north-east.

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The country about the site is, perhaps, best described as "mulga plain". It carries stunted mulga and is very poor pastoral country (Fig. 1). There is a stony soil cover and a tough ferruginous hardpan occasionally outcropping, but more often at depths up to one foot. Occasionally this hardpan is exposed at the surface or occurs as detached floaters.

History of the find and its recovery

This new meteorite find was made on 12th March, 1964 by Mr. W. C. Martin, senior partner in the Mt. Padbury Pastoral Company, during the course of mustering sheep. Despite protests from a companion that the material was valueless, Mr. Martin took some pieces from one of the "outcrops" back to the station homestead. There his partner, Mr. A. H. Bell, attempted to "dolly" one of the pieces for gold and also applied an oxy-acetylene flame to the material, causing a white metal to run from it. Still puzzled, Mr. Bell forwarded pieces to the School of Mines in Kalgoorlie for identification. There they came to the attention of the writer and were identified as a mesosiderite, a stony-iron meteorite of rare type.

Mr. Bell described the occurrence in general terms as possibly several hundredweights of material, occurring in four or five small outcrops

Fig. 1. Mass 1.—The largest piece of the Mt. Padbury meteorite (195 lb.) in situ, with detached fragments in foreground. Mr. W. C. Martin, the finder (on left) and his partner, Mr. A. H. Bell, who called attention to the material. Note the stony, almost "gibber-plain" surface and the poor mulga vegetation.

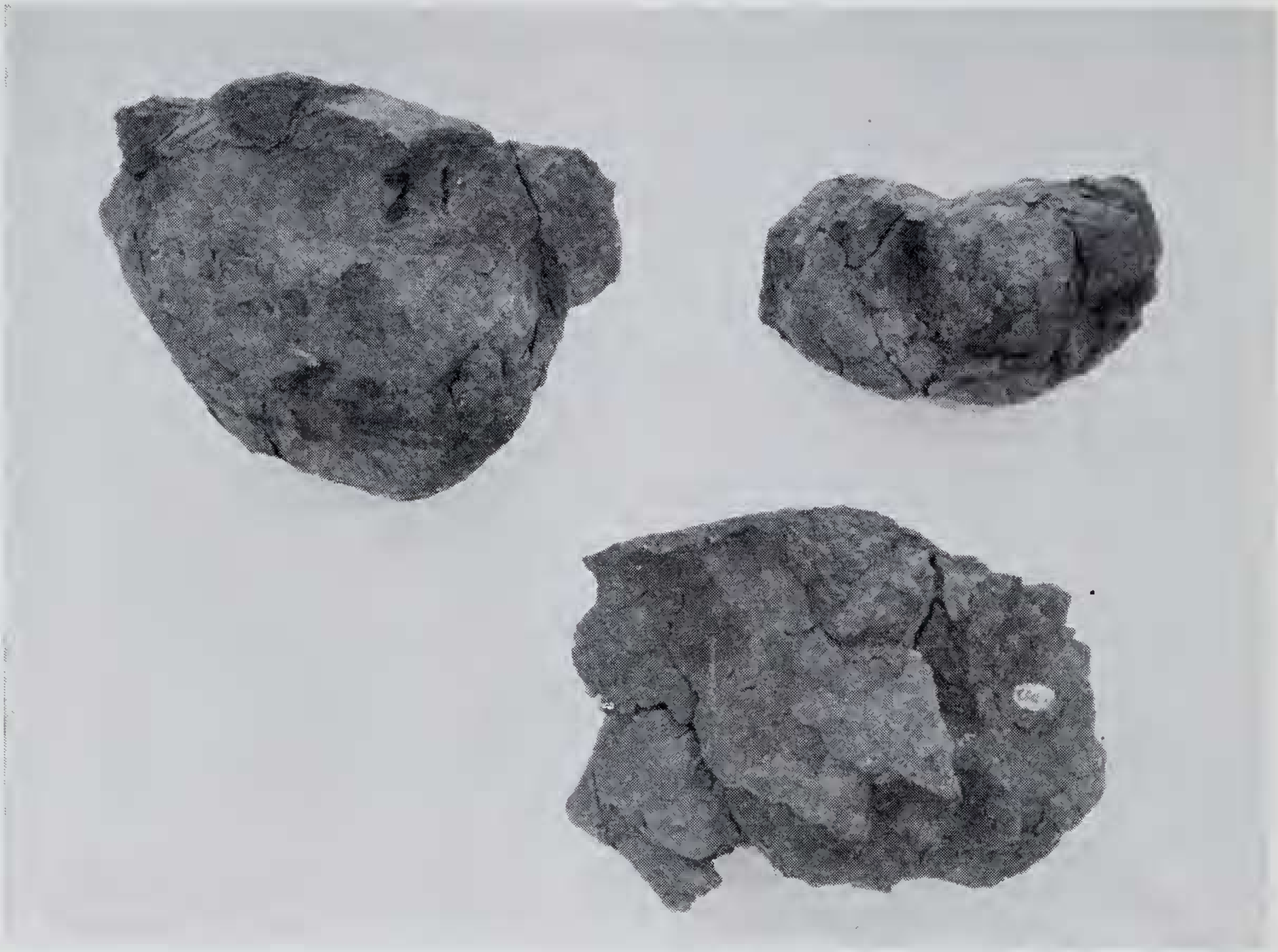

Fig. 2.—Side elevations of three major fragments showing weathering effects. The upper surfaces of all are original dimpled surfaces. Top left: spheroidal core after loss of up to 2 in. by exfoliation from the underside. Bottom right: upward wedging cracks sub-divide the mass into individuals which weather spheroidally. Top right: cracking and weathering advanced, a well-defined spheroid in the middle. The two large specimens are one foot wide.

rising above the natural eement and spread over an area about thirty yards square. Knowledge of the manner of occurrenee of meteorites has frequently been lost in the past through thoughtless collecting, and this oecurrenee appeared from Mr. Bell's deseription to be unspoiled and to provide an ideal opportunity for accurate recording of details of distribution of the pieces. In response to a request from the writer, the finders removed no further material and it was subsequently possible to reeord and collect from the outerops with due eare. Eaeh outcrop was found to consist of a very badly weathered and disintegrating boulder of meteorite, embedded in the soil.

Distribution and state of the material

The larger pieces of meteorite were embedded to about the depth of the ferruginous hardpan, but no worthwhile material was recovered from below ground level. Each large mass showed more or less spheroidal weathering like boulders of dolerite. The material in the ground was completely decomposed and consisted of detached exfoliated slabs or scales of "onion-skin" type; the term "iron shale" is sometimes applied to decomposed material of this nature. It was collected with the intention of determining the extent and weight of eaeh mass rather than with any hope that it might be of value for petrographic study. Eaeh outcrop could be lifted off its weathered underpart. From the underside of some masses eraeks extended upward dividing them into spheroidally weathering parts (Fig. 2). Mass 3 was so frail as to fall apart at a touch. In eontrast, the upper surfaces of Masses 2 and 3 were dimpled and appear to be original surfaces; this dimpling on Mass 2 is shown in Fig. 3. Portion of the lateral surfaee of Mass 1 also showed this strueture. This survival is noteworthy beeause lower parts embedded in the ground were surrounded by up to 4″ of iron shale. That thickness might owe something to swelling consequent upon oxidation and hydration.

Of Mass 4, initially about 22 kg. in weight, the largest surviving fragment weighed only 0.7 kg., and the remainder was divided into hundreds of small fragments. The great bulk of the eurving or irregular fragments were quite useless as speeimen material but the rare rounded or ovoid pieces from this or other sources were of relatively high speeific gravity and fresh internally. Sueh rounded pieces are the innermost cores of the speroidally weathered masses.

Fig. 3.—Mass 2 disintegrated by secondary agencies and drifted apart. The largest pieces show the dimpled upper surface. There are quite a number of fragments in the foreground but the small pebbles are a soil constituent not meteoritic. Hammer length, 1 foot.

Following detachment of fragments as a result of weathering, there had been some secondary distribution of material by soil creep, rainwash or sheet floods, resulting in small eluvial or alluvial trails of fragments. There is also a possibility that rare, unusually wide floods of the Murchison river might have covered this point. Fragments which could be referred on the basis of proximity and slope to a particular parent mass were mapped and recorded as the eluvium of that mass (Figs. 4 and 5).

There remain some minor fragments of no evident parentage and these probably belong to at least three categories. Some groups of fragments could have resulted from disintegration of other original masses of small dimensions. "Mass" 7 (Fig. 5) is a group of 15 such fragments, the largest 0.3 kg. in weight, envisaged as parts of a hypothetical mass of about 1.2 kg. A fragment weighing 0.35 kg. found between Masses 1 and 6 was larger than any fragment in the eluvial trail of Mass 1 but had the exfoliated form and was quite isolated. Distribution of such fragments by human agency is a possibility; the site is close to an area which was thoroughly prospected for manganese. Finally, some pieces may be original and unrelated to distribution effects of weathering. A piece in this category is an ovoid one weighing 0.6 kg. and occurring 20′ in direction 170° from Mass 5 without accompanying debris. Fragments not known to be related to a parent mass are listed in the table of weights as "aberrant".

Reasons for the primary distribution of mass

When a meteorite is found as a number of related fragments, there are at least four possible reasons:

(a) Fragmentation pre-dating entry to the earth's atmosphere.

Fig. 4.—Eluvial spread from Mass 1 looking westerly towards the source. Fragments have been placed upon white sample bags. No attempt has been made to mark all the very numerous fragments near the source.

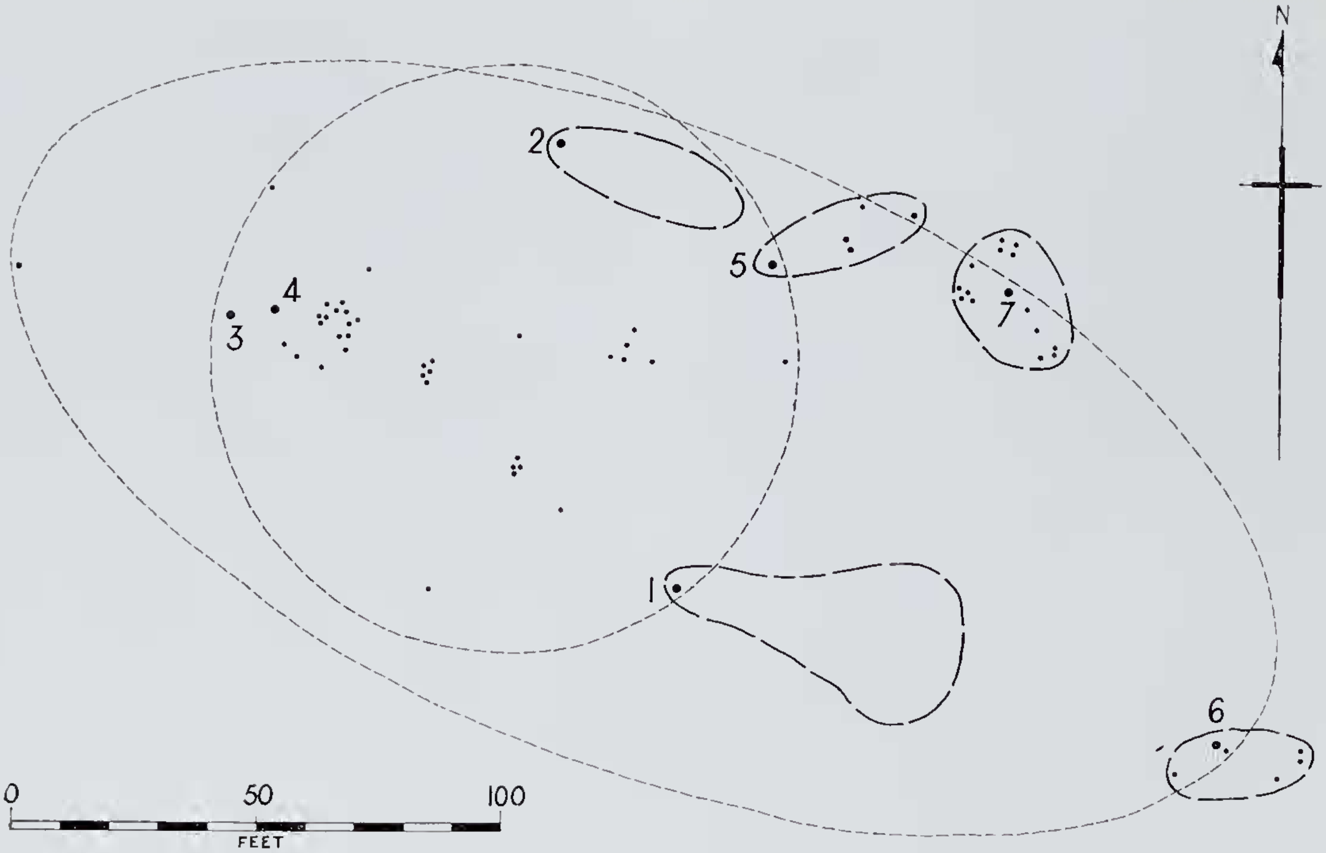

Fig. 5.—Distribution of the fragments of the Mt. Padbury meteorite. Larger masses are numbered and their eluvium is included within the broken lines. The very numerous fragments of Masses 1 and 2 are not shown individually. The circle is of 120 feet diameter, the ellipse 130 feet x 275 feet.

(b) Fragmentation consequent upon heating and the stresses of atmospheric flight.

(c) Fragmentation on impact.

(d) Disintegration by weathering and distribution by surface agencies.

The first impression in the field was that the major masses formed a triangle of about 90 feet side and their distribution might be due to fragmentation on impact. When further pieces were flagged it was evident that the distribution was roughly elliptical. This is the characteristic distribution of a shower of meteorite fragments.

If a group of fragments is visualized travelling earthward and gradually dispersing in flight then a cone of paths is formed. Generally, when the axis of the cone is not vertical, the earth's surface forms an elliptical impact area. In theory, the special case of a vertical axis and a circular impact area is also a possibility but such a special case will be a rarity. Ellipses of meteorite distribution are known varying from rough patterns to near-perfect ones.

The plot of the distribution (Fig. 5) illustrates the pattern recognised in the field. After allowing for the reconcentration of eluvial fragments with their parent masses, 94.4% of the weight of the collected material is represented by Masses 1 to 4 at the corners of a triangle and 98.7% lay within a circle of 120 feet diameter; the whole of the material can be included within an ellipse measuring 130′ x 275′, an area of 0.6 acre.

The stony soil and tough ferruginous hardpan would combine with the somewhat brittle nature of the meteorite itself to effect breakage on impact, and fractures will have been initiated by atmospheric flight stresses. However, the grouping of the fragments within a small area is the only real evidence for breakage on impact rather than before impact. The elliptical distribution favours arrival of the meteorite as a number of pieces and another point in favour is that the larger masses (which are numbered in order of decreasing weight) were embedded according to their weights. Mass 1 was embedded more than 8″, Masses 2 and 3 more than 6″, Mass 4 several inches, Mass 5 for 2″ and Mass 6 not at all. A depth of 2″ to 4″ is to be added for the three largest masses, being the thickness of the thoroughly weathered shells. These depth figures are too consistent to be fortuitous and, in any case, there appears to be no reason why fragments scattered on impact should be embedded to such depths. The very small size of the ellipse suggests fragmentation at a very late stage in flight; more commonly, ellipses are measurable in miles.

It is a possibility that the dimpled surfaces present on the three biggest masses are parts of the original surface because at least two or three of the dimples coincide with large silicate grains and they could therefore be an ablation effect. They might represent parts of a posterior surface, somewhat protected during oriented atmospheric flight. However, the state of the material is such that it is impossible to attempt a reconstruction and this idea therefore remains as speculation.

Table 1
Weights (kilograms) of Mt. Padbury Meteorite

Mass 1	Main mass	88·65	Total 113·5
	Weathered debris	17·70	
	Eluvium	7·15	
Mass 2	Largest piece	31·80	Total 71·8
	Other pieces—10·9, 1·5, 1·4, 0·7	14·50	
	Weathered debris	24·15	
	Eluvium	1·35	
Mass 3	Largest piece	24·00	Total 62·1
	Other pieces—10·2, 3·1, 2·7, 1·6, 1·0, 0·6	19·20	
	Weathered debris	18·90	
Mass 4	Largest piece	0·70	Total 21·9
	Other pieces, mostly weathered debris	21·20	
Mass 5	Largest piece	5·50	Total 8·9
	Other pieces, including eluvium	3·40	
Mass 6	Largest piece	1·10	Total 1·6
	Other pieces, including eluvium	0·50	
Mass 7	Eluvial fragments, largest 0·3		1·2
Aberrant fragments			3·1
Fragments not precisely located (including specimens submitted to School of Mines)			1·1
Total weight of weathered material			285·2

It is usually accepted that when meteorite fragments are distributed in an ellipse the largest fragments travel furthest because of their greater momentum. In the present instance, therefore, the direction of flight would be westerly, the bulk of mass being at the western end. Whether this argument remains valid for such a small ellipse is not known.

As a result of the limited time available many small fragments were not collected either from the surface or from the soil beneath the masses. This deficiency is likely to be compensated or over-compensated by the weathered condition and consequent enhanced weight of much of the material.

A rough estimate of the fresh weight may be made as follows:— It is assumed that all but a few of the larger masses are in a thoroughly rusted condition, that the meteorite was about two-thirds metal and that subsequent rusting doubled the original weight of the metallic portion. The weight of the partly weathered material (285.2 kg, see Table 1) should therefore be reduced by two-fifths of the weight of the thoroughly weathered fraction. On this basis, a round figure of 250 kg. is perhaps the closest approximation that can be made to the weight of the unweathered mass immediately after fall. The total weight of the material is equivalent to 627 lbs. and the estimated "fresh" weight is 550 lbs.

Acknowledgments

The greater bulk of the Mt. Padbury meteorite is in the collections of the Department of Geology, School of Mines of Western Australia, Kalgoorlie (catalogue numbers 9,625 and 9,635 to 9,658). A specimen of weight 5.5 kg is lodged in the Western Australian Museum, Perth (12,294). The generous gift of this material by Messrs. Martin and Bell is gratefully acknowledged as is also their kindness to the writer during the time he spent recovering the material.

Mr. M. K. Quartermaine took the photograph used as Fig. 2.

Dr. G. J. H. McCall kindly read the manuscript and suggested some minor amendments. A petrographic description of this material is being prepared by Dr. McCall and will be published in support of this initial account.